

A Monthly e Magazine
ISSN:2583-2212

May 2024 Vol.4(5), 1964-1969

Popular Article

Advancements in Dermatophyte Classification, Clinical Diagnosis and Treatment

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<https://doi.org/10.5281/zenodo.11428201>

Introduction

Dermatophytes are a type of fungi that target and break down tough tissues like hair, skin, nails, and feathers. They belong to a group called Ascomycota, within which they're classified under the Eurotiomycetes class, Onygenales order, and Arthrodermataceae family. Currently, there are seven recognized types of dermatophytes: Trichophyton, Epidermophyton, Nannizzia, Paraphyton, Lophophyton, Microsporum, and Arthroderma. In the past, naming these fungi was based on how they looked and the diseases they caused. But now, with advancements in science, we use a molecular approach for naming. This means we look at their genetic makeup to classify them properly. Before, there were separate names for their sexual and asexual forms, but now they're grouped under one name, following a "One Fungus = One Name" system (1). Dermatophytes are further divided into three groups based on where they live: some live on humans (anthropophilic), some on animals (zoophilic), and some in the environment (geophilic) (2).

Dermatophyte classification

Dermatophytes, categorizing them into anthropophilic, zoophilic, and geophilic groups based on their preferred habitats. Anthropophilic dermatophytes primarily infect humans and have adapted to human physiology, resulting in mild clinical signs. They are often associated with specific locations on the body, such as the feet (*tinea pedis*) or scalp (*tinea capitis*). Common species include *Trichophyton rubrum* and *Trichophyton interdigitale*. Zoophilic dermatophytes, on the other hand,

1964

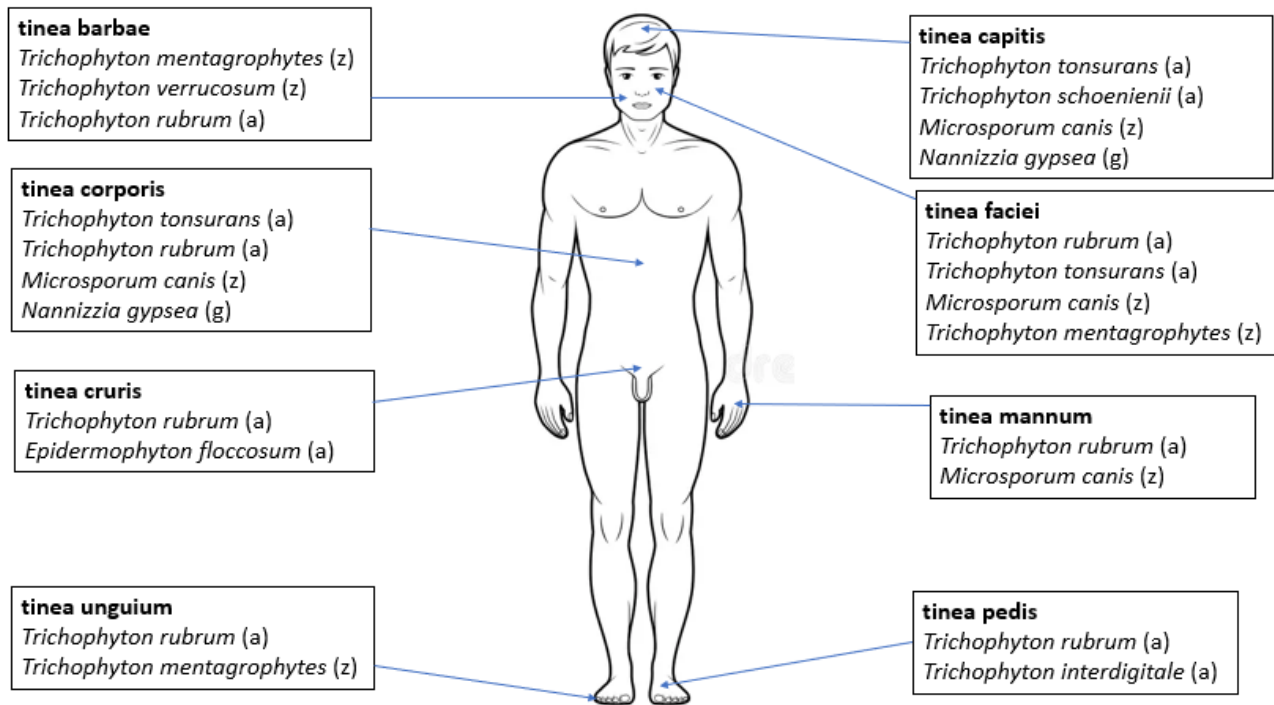
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Published 25.05.2024

typically infect animals but can also cause infections in humans, often resulting in more inflammation and shorter infection courses compared to anthropophilic dermatophytosis. Examples of zoophilic species include *Microsporum canis* and *Trichophyton mentagrophytes*. Geophilic dermatophytes mainly reside in soil and rarely cause infections in humans and animals. They are responsible for degrading keratin in soil and typically cause more severe inflammatory responses compared to anthropophilic and zoophilic dermatophytosis. *Nannizzia gypsea* is a common geophilic species (3).



Classification of dermatophytosis in humans. a- anthropophile; z - zoophile; g - geophile.

Initiation of dermatophyte infection in skin

When arthroconidia, the infectious spores of dermatophytes, come into contact with a new host's skin, they adhere to the surface within 2 to 6 hours. Subsequently, these arthroconidia start to germinate in the top layer of the epidermis, initiating the formation of germ tubes. As the infection progresses, hyphae, the branching filaments of the fungus, continue to grow within the epidermis, establishing a foothold. Within approximately 7 days of infection, new arthroconidia are formed, completing the cycle and allowing for the potential spread of the disease to other areas or individuals (4).

Signs and Symptoms of a Dermatophyte Infection

Signs and symptoms of dermatophyte infections vary depending on the infectious microorganism, affected area, and the severity of the infection. Most infections tend to be superficial and localized to a specific part of the body, such as the feet, scalp, or nails. However, the simultaneous presence of more than one type of tinea is common, and can occur from direct spreading from one

area to another. In addition, tinea infections can become complicated by secondary bacterial infections, which occur when different opportunistic bacteria infect the lesions caused by dermatophytes.

- **Tinea corporis** also known as ringworm, typically presents with a round, red, itchy rash that has an inflamed, scaly border. These lesions tend to grow in an outward pattern creating a characteristic ring-like appearance, hence the name “ringworm”. Healthy individuals typically present with one or more of these lesions, whereas individuals with a decreased immune response are at risk of developing more invasive and widespread infections.
- Majocchi’s granuloma, also known as fungal folliculitis, is a rare form of tinea corporis that occurs when dermatophytes penetrate the skin through damaged hair follicles, causing a deep skin infection. In otherwise healthy individuals, Majocchi’s granuloma presents with small skin lesions and inflamed hair follicles in areas that are prone to trauma, such as the legs, arms, and ankles. Meanwhile, individuals with a decreased immune response may present with more severe manifestations, such as deep subcutaneous plaques and nodules.
- **Tinea capitis** can either be inflammatory or non-inflammatory, depending on the causative microorganism. Inflammatory tinea capitis can present with a pus-filled lump on the scalp that may leave a localized area of scarring and permanent hair loss. On the other hand, non-inflammatory tinea capitis can present with itchiness, scaling, and reversible hair loss.
- **Tinea faciei** affects the facial skin and can sometimes occur from the direct spreading of a scalp infection, especially in children. It generally presents with a skin rash that worsens after sunlight exposure. Additionally, tinea barbae affects the hair follicles and skin of bearded individuals and can present with areas of increased redness, scaling, and pus-filled lesions.
- **Tinea pedis**, also known as athlete's foot, presents with areas of scaling as well as the softening and breaking of the skin in the spaces between the toes and the soles of the feet. Less frequently, tinea pedis can present with erosions and painful open sores in between the toes.
- **Tinea manuum** can occur in individuals with tinea pedis due to direct spreading of the infection from the feet to the hands. It typically presents with dry skin in the palms of the hands and a skin rash with inflamed, scaly borders on the back of the hand.
- **Dermatophyte nail infections, or tinea unguium**, can cause white or yellow discoloration of the nails, as well as either thickened or brittle nails. Severe nail infections can cause a complete breakdown of the nail itself, which can then become separated from the nailbed. Generally,



toenails are more often affected than fingernails, and individual nails are sometimes spared (5).

Diagnosis

- Dermoscopy is employed in human medicine to examine cutaneous lesions, including those on hair and nails, offering a non-invasive approach for diagnosis and treatment monitoring. Advancements like polarized light sources and mobile device attachments enhance observation. In veterinary medicine, it mainly examines hair follicles and skin, but compliance can be an issue. Accuracy relies heavily on the examiner's skills and expertise.
- The Wood's Lamp is frequently employed to diagnose dermatophytosis, particularly in screening animals in shelter environments. It operates by using UV light to identify fluorescence on the skin and hair, indicative of active dermatophyte infection. However, not all dermatophyte species fluoresce, leading to potential false positives caused by other infections and dermatological disorders.
- Microscopy techniques such as potassium hydroxide (KOH) preparation and lactophenol cotton blue staining visualize fungal elements. Histopathology aids in diagnosing deep dermatophyte infections by examining dermis or deeper tissues and using stains like periodic acid-Schiff (PAS), Gomori's modification of methenamine silver (GMS), and calcofluor white to visualize fungi.
- Culture isolation and identification, considered the gold standard for diagnosing dermatophytosis, involve using Dermatophyte Test Medium (DTM) and Sabouraud dextrose agar (SDA) as common culture media. Differentiating *Trichophyton* and *Microsporum* species utilizes various media and conditions. Dermatophytes produce three types of asexual conidia in culture: macroconidia, microconidia, and arthroconidia. Cultures, grown at room temperature, are observed for up to 4 weeks due to slow growth of some species, requiring diagnostic expertise for species identification.
- Polymerase Chain Reaction (PCR) is highly sensitive for detecting dermatophytes, even when cultures are negative. However, it cannot differentiate between living and dead fungal cells, leading to potential false negatives and positives. Accurate PCR relies on specialized DNA extraction protocols. Qualitative PCR targets the internal transcriber spacer (ITS) region for species-level identification, while real-time PCR (RT-PCR) can distinguish between dermatophyte species in clinical samples.



- Antibody-based assays, like ELISA, offer an alternative method for detecting dermatophytes. ELISA employs various techniques and detection systems, providing versatility in detection. Despite showing promise in detecting dermatophytes using serum samples, ELISA assays face challenges such as the risk of false positives due to persistent antibodies post-infection and the invasive nature of serum sample collection.
- Mass Spectrometry, particularly MALDI-ToF MS, is recognized for detecting and identifying fungal species, including dermatophytes, via protein spectra. However, its effectiveness

depends on a comprehensive organism library, limiting utility for novel or rare species. Challenges include specialized equipment, ongoing library updates, and potential issues like cross-contamination and high costs. Despite challenges, there's demand for affordable, user-friendly assays to overcome current limitations in dermatophyte diagnosis (4).

Treatment

Treatment of dermatophyte infections involves general measures such as wearing loose-fitting cotton or synthetic clothing to wick moisture away from the skin and avoiding sharing garments and towels. Regular washing and drying of undergarments, socks, and caps are recommended. For conditions like tinea cruris, addressing contributing factors like excessive sweating or obesity is crucial. Prophylactic use of imidazole or tolnaftate powders and avoiding occlusive footwear are advised for tinea pedis. Maceration or malodor should prompt a search for secondary bacterial infections. At the community level, maintaining hygiene in high-risk areas like swimming baths is essential.

Treatment in elderly patients must be individualized considering comorbidities and drug interactions. Topical therapy may suffice for healthy elderly patients with single lesions, while systemic therapy is indicated for extensive or refractory infections. Various topical creams are available, with some, like butenafine and terbinafine, showing superior efficacy. Systemic therapy options include oral itraconazole and terbinafine, with terbinafine being preferred due to fewer drug interactions.

In children, topical antifungals are generally used, with oral griseofulvin and terbinafine reserved for extensive or refractory cases. Terbinafine has been found effective and safe in children, with few adverse effects reported.

For pregnant women, topical azoles are preferred due to minimal systemic absorption. Oral fluconazole, itraconazole, and griseofulvin are best avoided during pregnancy due to safety concerns (6).

1968



Conclusion

Dermatophyte infections in humans encompass a spectrum of conditions, ranging from superficial and localized to potentially deep and invasive. Recognizing the signs and symptoms associated with each type of infection is crucial for accurate diagnosis and effective management. Various diagnostic methods, from dermoscopy to PCR, offer diverse approaches to identifying these fungal pathogens. Treatment strategies, including both topical and systemic antifungal therapies, are tailored to individual patient characteristics, such as age, comorbidities, and pregnancy status. Additionally, implementing preventive measures, such as maintaining good hygiene practices and avoiding shared garments, can help reduce the risk of infection transmission. Overall, a comprehensive understanding of dermatophyte infections, coupled with appropriate diagnostic and therapeutic interventions, is essential for optimal patient care and management.

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